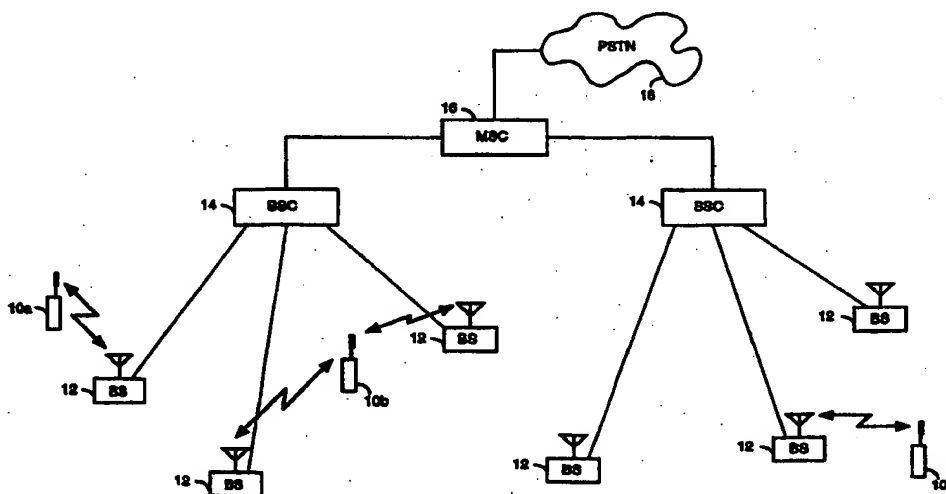




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04J	A2	(11) International Publication Number: WO 98/59449 (43) International Publication Date: 30 December 1998 (30.12.98)
(21) International Application Number: PCT/US98/13103 (22) International Filing Date: 24 June 1998 (24.06.98) (30) Priority Data: 08/881,552 24 June 1997 (24.06.97) US (71) Applicant: QUALCOMM INCORPORATED [US/US]; 6455 Lusk Boulevard, San Diego, Ca 92121 (US). (72) Inventor: ANTONIO, Franklin, P.; 2765 Cordoba Cove, Del Mar, CA 92014 (US). (74) Agents: MILLER, Russell, B. et al.; Qualcomm Incorporated, 6455 Lusk Boulevard, San Diego, CA 92121 (US).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>Without international search report and to be republished upon receipt of that report.</i>	

(54) Title: A METHOD AND SYSTEM FOR CONDUCTING WIRELESS COMMUNICATIONS



(57) Abstract

A method and system is described for conducting wireless communications, such as the transmission of voice and data in a code division multiple access (CDMA) wireless telecommunications systems. In an exemplary embodiment of the invention, a base station (12) transmits voice information at voice transmit power and data at a data transmit power that is equal to a maximum transmit power minus the voice transmit power. In a preferred embodiment of the invention, each base station (12) reports the voice transmit power to a base station controller (14) in 20 ms intervals. The base station controller (14) responds by calculating an available data transmit capacity, and by forwarding data to each base station (12) equal to the available data transmit capacity. Each base station (12) then transmits all voice data at the current voice transmit power, and data at the current data transmission power. If the amount of data received exceeds the capacity provided by the current data transmission power, some data is not transmitted. The base station (12) then notifies the base station controller (14) if data was not transmitted, and the base station controller attempts to retransmit the data at a later time.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

A METHOD AND SYSTEM FOR CONDUCTING WIRELESS COMMUNICATIONS

BACKGROUND OF THE INVENTION

5

I. Field of the Invention

The present invention relates to a method and system for conducting wireless communications. The present invention is suitable for use in transmitting voice and data in a code division multiple access (CDMA) wireless telecommunications system.

II. Description of the Related Art

One measure of the usefulness of a wireless communication system is the efficiency with which it uses the available RF bandwidth. In some instances, efficiency is defined as the sustainable data transmission rate of a system over a given amount of RF bandwidth. In other instances, efficiency is characterized as the total number of communications (such as telephone calls) that can be simultaneously conducted using a given amount of bandwidth. Whatever the measure, increasing efficiency generally increases the usefulness of a wireless communication system.

An example of an especially efficient, and therefore especially useful, wireless communication system is shown in FIG. 1, which is a highly simplified illustration of a wireless cellular telephone system configured in accordance with the IS-95 over-the-air interface standard adopted by the Telecommunications Industry Association (TIA). The IS-95 standard and its derivatives such as IS-95-A etc. (referred to herein collectively as the IS-95 standard) define a set of code division multiple access (CDMA) signal processing techniques for implementing a cellular telephone system. A cellular telephone system configured substantially in accordance with the IS-95 standard is described in US Patent number 5,103,459 entitled "SYSTEM AND METHOD FOR GENERATING SIGNAL WAVEFORMS IN A CDMA CELLULAR TELEPHONE SYSTEM" assigned to the assignee of the present invention and incorporated herein by reference.

In accordance with the IS-95 standard, subscriber units 10a - c (usually cellular telephones) conduct telephone calls and other communications by interfacing with one or more base stations 12 using the CDMA modulated RF signals. Each interface is comprised of a forward link signal transmitted

from the base station 12 to the subscriber unit 10, and a reverse link signal transmitted from the subscriber unit 10 to the base station 12.

Base station controllers (BSC) 14 perform various functions that allow mobile communication to take place, including orchestrating the handoff of a subscriber unit 10 between two base stations 12. Mobile switching center (MSC) 16 provides call processing and routing functionality to allow communication with public switched telephone network (PSTN) 18.

The use of CDMA modulation techniques as specified by the IS-95 standard makes each RF signal appear as background noise during the processing of any particular RF signal. Making other signals appear as background noise allows transmission of multiple RF signals over the same RF bandwidth. Transmitting multiple signals over the same RF bandwidth increases the frequency reuse of the cellular telephone system, which in turn increases the overall capacity.

To further increase overall system capacity, IS-95 varies the average transmit power of a signal in response to changes in voice activity. The average transmit power is varied in 20 ms increments, either by a reduction in the transmit duty cycle, or an actual transmit power reduction. By varying the average transmit power in response to voice activity, the average total power used by the RF signal to conduct communication is reduced.

Because voice activity is essentially random, however, the total transmit power of an IS-95 compliant base station varies over time in response to changes in voice activity. Thus, when voice activity is low, or few conversations are being conducted, the base station will transmit data at much less than its maximum rate, leaving valuable bandwidth unused.

Furthermore, varying transmit power with voice activity creates a degree of uncertainty as to the total transmit power that will be used at any particular instant. To account for this uncertainty, IS-95 compliant base stations typically transmit at less than the maximum rate to establish reserve transmit power for handling bursts of increased speech activity. Maintaining this reserve, however, also causes the average transmission rate to be less than the maximum transmission rate of which base station is capable.

In any case, transmitting at an average rate that is less than the maximum rate is undesirable, as it does not utilize the available RF bandwidth as efficiently as possible. To increase the usefulness of a CDMA wireless communication system, the present invention is directed towards allowing the average data transmission rate to more closely equal the

maximum transmission capacity of a base station 12, and therefore towards increasing the efficiency with which the allocated RF bandwidth is used.

SUMMARY OF THE INVENTION

5

The present invention aims to provide a novel method and apparatus for transmitting voice and data in a code division multiple access (CDMA) wireless telecommunications system. In an exemplary embodiment of the invention described herein, a base station transmits voice information at voice transmit power and data at a data transmit power that is equal to a maximum transmit power minus the voice transmit power. In a preferred embodiment of the invention, each base station reports the voice transmit power to a base station controller in 20 ms intervals. The base station controller responds by calculating an available data transmit capacity, and by forwarding data to each base station equal to the available data transmit capacity. Each base station then transmits all voice data at the current voice transmit power, and data at the current data transmission power. If the amount of data received exceeds the capacity provided by the current data transmission power, some data is not transmitted. The base station then notifies the base station controller if data was not transmitted, and the base station controller attempts to retransmit the data at a later time.

According to one aspect of the invention there is provided a method for performing wireless communications using a base station having a maximum transmit power P_{\max} comprising the steps of: a) transmitting voice frames received at a voice transmit power P_{voice} ; and b) transmitting data frames at a data transmit power less than $P_{\max} - P_{\text{voice}}$.

According to another aspect of the invention there is provided a system for conducting wireless communications comprising: a base station controller for transmitting a set of data frames and a set of voice frames; and a base station for transmitting said set of voice frames and for transmitting at least a portion of said data frames when additional capacity exists.

According to a further aspect of the invention there is provided a system for conducting wireless communications comprising: means for generating a set of data frames and a set of voice frames; and means for transmitting said set of voice frames and for transmitting at least a portion of said data frames if additional capacity exists.

BRIEF DESCRIPTION OF THE DRAWINGS

Features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below of an embodiment of the invention when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is block diagram of a cellular telephone system;

FIG. 2 is a block diagram of a cellular telephone system configured in accordance with one embodiment of the invention; and

FIG. 3 is a flow diagram illustrating the operation of a cellular telephone system configured in accordance with one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 2 is a block diagram of a portion of a cellular telephone system including a base station controller (BSC) 34, a pair of base stations 32, and a set of subscriber units 30 configured in accordance with one embodiment of the invention. Subscriber units 30 conduct telephone calls by establishing bidirectional RF links with base stations 32. The bidirectional links are comprised of a forward link signal transmitted from each base station 32, and a reverse link signal transmitted from each subscriber unit 30.

In a preferred embodiment of the invention, the forward and reverse link signals are processed in accordance with the IS-95 over-the-air interface standard, which calls for the use of CDMA signal processing. CDMA signal processing allows multiple spread spectrum RF signals to be transmitted at the same RF frequency range via modulation and demodulation with a set of pseudorandom noise (PN) codes.

Each base station 32 conducts communications with multiple subscriber units 30 by generating a set of forward link signals. (The term "forward link signal" is also used to describe a set of forward link signals transmitted from a base station 32, however, for the purpose of describing the present invention, forward link signal refers to a forward link transmission used for a single traffic channel.) Additionally, each base station 32 receives a set of reverse link signals from a set of subscriber units 30.

The number of forward link signals that can be transmitted simultaneously by a base station 32 is typically limited by the maximum

transmit power capability (P_{\max}) of the particular base station 32, the amount of multipath generated, or a predetermined limit set in response to a network plan. The number of reverse link signals is typically limited by the bit energy to noise ratio (E_b/N_0) required by a base station 32 to properly process a particular reverse link signal.

The IS-95 standard also calls for the data transmitted over the forward and reverse link signals to be processed in 20 ms increments that correspond to frames. Within BSC 34 and base stations 32, the various subsystems shown exchange the frames, as well as control information such as signaling messages, via the use of packets. The packets contain an address that indicates the subsystem to which they are directed, so that they may be properly routed by CDMA interconnect subsystem (CIS) 40. Management system 44 controls the configuration and operation of the other systems that make up BSC 34 via signaling messages also transmitted using packets using information stored in subscriber database 46.

In accordance with the IS-95 standard, a subscriber unit 30 can enter soft handoff, as shown in FIG. 2, whereby two or more bidirectional RF links are simultaneously established with two or more corresponding base stations 32. Soft handoff allows a subscriber unit 30 to move from the coverage area of one base station 32 to the coverage area of another base station 32 while maintaining at least one bidirectional link at all times. Soft handoff can be contrasted with hard handoff during which the first bidirectional interface is terminated before the second bidirectional interface is established.

To conduct soft handoff, a set of selectors (not shown) within selector bank 42 perform various functions including performing call distribution and call selection functions used for conducting soft handoff, as well as tracking the base station or stations 32 with which a subscriber unit 30 is interfacing at any given time. The selectors are preferably comprised of a set of software instructions running on one or more microprocessors.

Call distribution involves generating copies of each frame directed to the subscriber unit 30 in soft handoff (usually received from MSC 16), and forwarding one copy of the frame to each base station 32 interfacing with that subscriber unit 30. Thus, one copy of the frame is transmitted from each base station 32.

Call selection involves receiving a set of frames from the set of base stations 32 interfacing with the subscriber unit 30 during the soft handoff, and selecting one frame for further processing based on the integrity or

quality of the frames. The selected frame is generally forwarded to the MSC 16 for introduction into PSTN 18.

Preferably, base stations 32 receive two types of frames from BSC 34 during the processing of a set of voice phone calls and data communications: frames containing voice information (voice frames) and frames containing data information (data frames). Each base station 32 responds to the two types of frames by transmitting all the voice frames received at a total transmit power P_{voice} and by transmitting a set of data frame at a total transmit power P_{data} that is less than or equal to $P_{\text{max}} - P_{\text{voice}}$.

By transmitting data frames in addition to voice frames, the average power at which the base station transmits is increased with respect to a base station transmitting only voice frames. In particular, the base station 32 transmits more closely to its maximum transmit power P_{max} at any given instant. This increases the average transmit power and therefore increases the total amount of information that is transmitted by the base station 32. Increasing the total amount of information transmitted, in turn, increases the efficiency with which the base station 32 uses the available RF bandwidth. Furthermore, by transmitting data frames at a transmit power that is less than or equal to $P_{\text{max}} - P_{\text{voice}}$, the average transmit power of a base station 32 is increased without interfering with the set of voice communications already being conducted.

FIG. 3 is a flow chart illustrating the steps performed by BSC 34 and base stations 32 during the processing of voice and data frames in accordance with one embodiment of the invention. The processing begins at step 70, and at step 72 a set of selectors within selector bank 42 notifies the base stations 32 when they have data queued for transmissions via the use of signaling messages transmitted to subscriber unit 30. The data frames are received from MSC 16 and are directed to a subscriber unit 30. In one embodiment of the invention, the data frames are distinguished from voice data files via the use of one or more status bit contained in each frame.

At a time T_0 , each base station 32 receives a set of the signaling messages from the selectors, and calculates a value N equal to the number of selectors having a data frame queued for transmission. Additionally, each base station 32 calculates a value E_{bx} equal to the average energy used to transmit a bit of data, as well as a value $P(T_0)_{\text{voice}}$ equal to the transmit power used at time T_0 to transmit all the voice frames being processed.

At step 74, each base station transmits the values N , E_{bx} and $P(T_0)_{\text{voice}}$ to each selector having data frames queued for transmission. At step 76, each selector calculates a value B_{min} as the minimum of a set of values $B(1)_{\text{bs}}$

.. $B(n)_{bs}$ where $B(n)_{bs} = (P_{max} - P(T_0)_{voice}) / (N \cdot E_{bx})$ for a base station 32, n being used to conduct the associated telephone call. That is, if the subscriber unit involved in the telephone call is in a soft handoff involving two base stations 32, two values $B(1)_{bs}$ and $B(2)_{bs}$ are calculated, and B_{min} is set to the lower of $B(1)_{bs}$ and $B(2)_{bs}$. In an alternative embodiment of the invention, B_{min} is set to the higher of $B(1)_{bs}$ and $B(2)_{bs}$.

Once B_{min} has been calculated, the selector transmits a data frame having B_{min} bits of data to each base station 32 involved in the call.

At step 77 occurring at a time T_1 which is after time T_0 , each base station 32 receives a set of data frames and a set of voice frames from the selectors, and calculates a value $P(T_1)_{data}$ equal to the power necessary to transmit the data frames received, as well as a value $P(T_1)_{voice}$ equal to the power necessary to transmit the voice frames received. Using $P(T_1)_{data}$ and $P(T_1)_{voice}$, each base station 32 determines if $P(T_1)_{data} + P(T_1)_{voice}$ is less than or equal to the maximum transmit power P_{max} of the base station 32 at step 78. That is, each base station 32 determines if $P(T_1)_{data} + P(T_1)_{voice} \leq P_{max}$. If so, all the data frames are transmitted along with the voice frames at step 80, and then the base station 32 returns to step 72. While the use of P_{max} is preferred, the use of other thresholds less than P_{max} is consistent with the use of the present invention.

If a base station determines at step 78 that $P(T_1)_{data} + P(T_1)_{voice}$ is greater than the maximum transmit power P_{max} , the base station 32 transmits a set of randomly selected data frames having $(P_{max} - P(T_1)_{voice}) / E_{bx}$ bits of data at step 82. Then, at step 84 the base station 32 notifies the selectors which did not have their data frames transmitted. These selectors can then attempt to retransmit the data contained in these data frames at a later time.

Generally, most or all of the data frames received by a base station 32 will be transmitted at time T_1 because the transmit power used to transmit the voice frames at time T_0 will differ little from the necessary voice frame transmit power at time T_1 . Thus, if any demand to transmit data exists, base station 32 will transmit, on average, more closely to the maximum power level. This allows the cellular telephone system to more efficiently use the available RF bandwidth.

When the transmit power necessary at time T_1 to transmit all the voice frames increases relative to the transmit power necessary at T_0 , the present invention limits the transmission of data frames to that which will cause P_{max} power to be used, while allowing all voice frames to be transmitted. This ensures that all the telephone calls being conducted will continue without interruption, while also allowing the maximum number

of data frames to be transmitted given the maximum transmit power P_{\max} of a base station 32.

Thus, a novel and improved method and apparatus for transmitting voice and data in a code division multiple access (CDMA) wireless telecommunications systems is described. The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

15 I CLAIM:

CLAIMS

1. A method for performing wireless communications using a base station having a maximum transmit power P_{\max} comprising the steps of:

- a) transmitting voice frames received at a voice transmit power P_{voice} ; and
- b) transmitting data frames at a data transmit power less than $P_{\max} - P_{\text{voice}}$.

2. The method as set forth in claim 1 wherein step b) is comprised of the steps of:

- b.1) receiving a set of data frames;
- b.2) calculating an amount of power necessary to transmit all of said set of data frames;
- b.3) transmitting all of said data frames if said amount of power is less than $P_{\max} - P_{\text{voice}}$; and
- b.4) transmitting a portion of said data frames if said amount of power is greater than $P_{\max} - P_{\text{voice}}$.

3. The method as set forth in claim 1 or 2 further comprising the steps of:

- determining a number of queued frames;
- determining an available number of bits per frame using said number of queued frames, an available transmit power, and a energy per bit value; and
- providing said number of queued frames, each having said available number of bits per frame.

4. A system for conducting wireless communications comprising:

- a base station controller for transmitting a set of data frames and a set of voice frames; and
- a base station for transmitting said set of voice frames and for transmitting at least a portion of said data frames when additional capacity exists.

5. The system as set forth in claim 4 wherein said
2 additional capacity exists if additional transmit power is available while said
voice frames are being transmitted.

6. The system as set forth in claim 4 or 5 wherein said base
2 station is further for indicating a first time additional capacity to said base
station controller, and said base station controller is for setting said set of
4 data frames to have an amount of data equal to said first time additional
capacity.

7. The system as set forth in claim 6 wherein said base
2 station transmits a portion of said set of voice frames if a second time
additional capacity is less than an amount of transmit power necessary to
4 transmit all of said set of data frames.

8. The system as set forth in claim 7 wherein said base
2 station notifies said base station controller of a portion of said set of voice
frames that were not transmitted.

9. A system for conducting wireless communications
2 comprising:

means for generating a set of data frames and a set of voice
4 frames; and

means for transmitting said set of voice frames and for
6 transmitting at least a portion of said data frames if additional capacity exists.

10. The system as set forth in claim 9 wherein said
2 additional capacity exists if additional transmit power is available while said
voice frames are being transmitted.

11. The system as set forth in claim 9 or 10 wherein said
2 means for transmitting is further for indicating a first time additional
capacity to said means for generating, and said means for generating is for
4 setting said set of data frames to have an amount of data equal to said first
time additional capacity.

12. The system as set forth in claim 9, 10 or 11 wherein said
2 means for transmitting transmits a portion of said set of voice frames if a
second time additional capacity is less than an amount of transmit power
4 necessary to transmit all of said set of data frames.

13. The system as set forth in claim 12 wherein said means
2 for transmitting notifies said means for generating of a portion of said set of
voice frames that were not transmitted.

14. The system as set forth in any of claims 9 to 13 wherein
2 said means for transmitting and said means for generating are coupled via a
wireline connection.

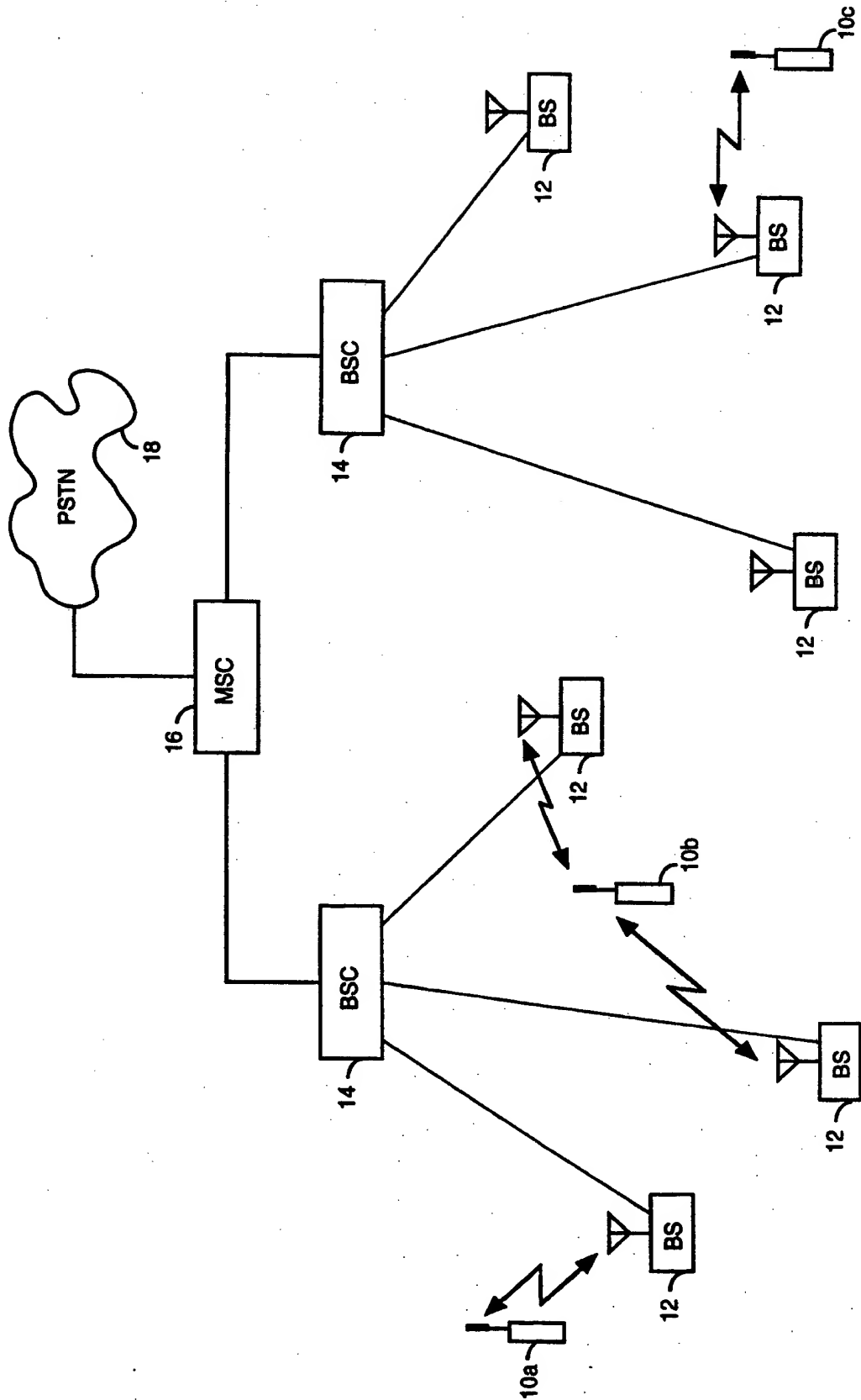


FIG. 1

2/3

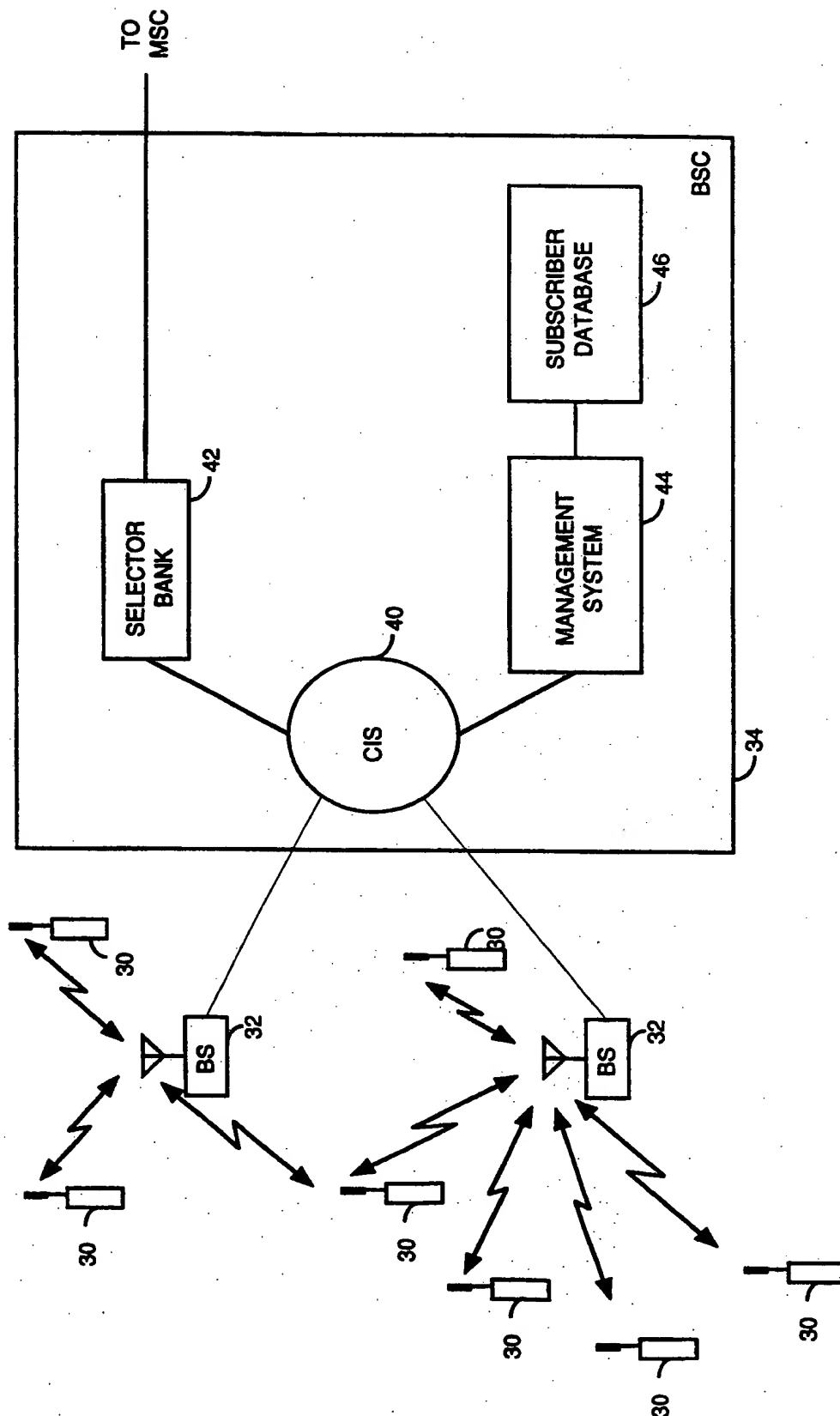


FIG. 2

3/3

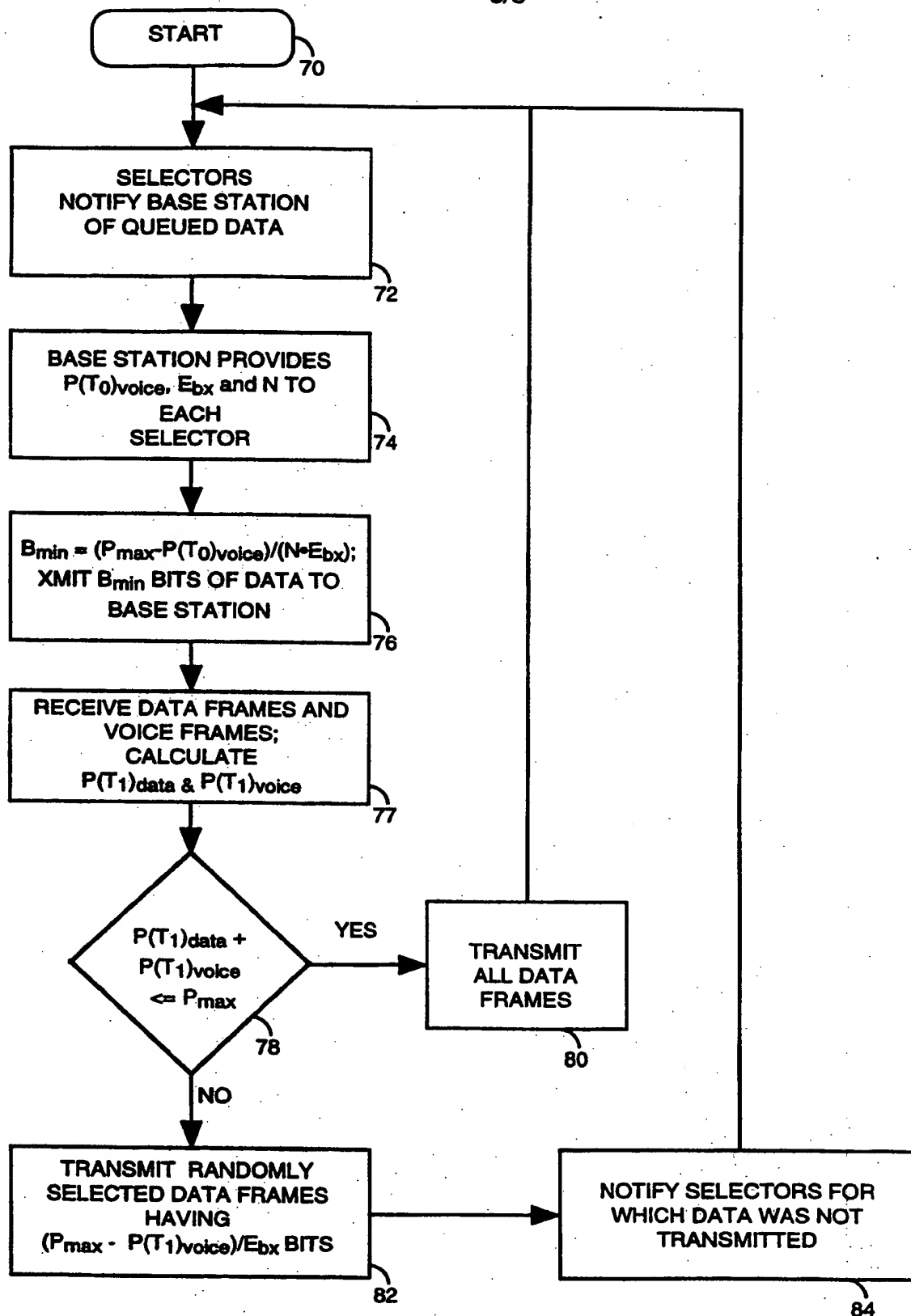
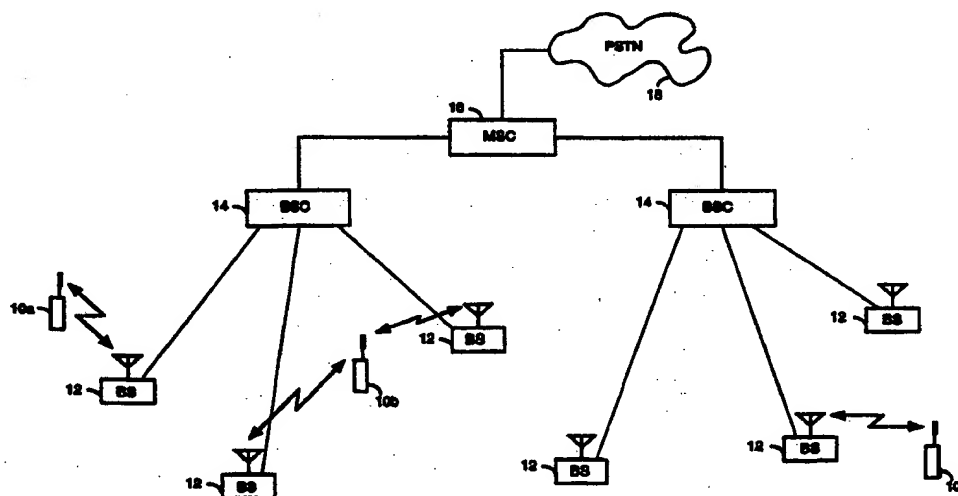


FIG. 3



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04B 1/707, 7/005	A3	(11) International Publication Number: WO 98/59449 (43) International Publication Date: 30 December 1998 (30.12.98)
(21) International Application Number: PCT/US98/13103 (22) International Filing Date: 24 June 1998 (24.06.98) (30) Priority Data: 08/881,552 24 June 1997 (24.06.97) US (71) Applicant: QUALCOMM INCORPORATED [US/US]; 6455 Lusk Boulevard, San Diego, Ca 92121 (US). (72) Inventor: ANTONIO, Franklin, P.; 2765 Cordoba Cove, Del Mar, CA 92014 (US). (74) Agents: MILLER, Russell, B. et al.; Qualcomm Incorporated, 6455 Lusk Boulevard, San Diego, CA 92121 (US).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> (88) Date of publication of the international search report: 17 June 1999 (17.06.99)	

(54) Title: A METHOD AND SYSTEM FOR WIRELESS COMMUNICATION**(57) Abstract**

A method and system is described for conducting wireless communications, such as the transmission of voice and data in a code division multiple access (CDMA) wireless telecommunications systems. In an exemplary embodiment of the invention, a base station (12) transmits voice information at voice transmit power and data at a data transmit power that is equal to a maximum transmit power minus the voice transmit power. In a preferred embodiment of the invention, each base station (12) reports the voice transmit power to a base station controller (14) in 20 ms intervals. The base station controller (14) responds by calculating an available data transmit capacity, and by forwarding data to each base station (12) equal to the available data transmit capacity. Each base station (12) then transmits all voice data at the current voice transmit power, and data at the current data transmission power. If the amount of data received exceeds the capacity provided by the current data transmission power, some data is not transmitted. The base station (12) then notifies the base station controller (14) if data was not transmitted, and the base station controller attempts to retransmit the data at a later time.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 98/13103

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04B1/707 H04B7/005

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 04718 A (QUALCOMM INC.) 15 February 1996 see abstract see page 2, line 14 - line 31	1-14
A	WO 97 03403 A (NOKIA TELECOMMUNICATIONS OY) 30 January 1997 see abstract see page 1, line 24 - page 2, line 2 see page 3, line 9 - line 29	1-14
A	US 5 568 483 A (PADOVANI ET AL) 22 October 1996 see abstract see column 4, line 56 - line 65; figure 1	1-14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

Date of the actual completion of the international search

8 Apr11 1999

Date of mailing of the international search report

15/04/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 661 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

O'Reilly, D

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. J. Application No

PCT/US 98/13103

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9604718 A	15-02-1996	US 5822318 A	13-10-1998
		AU 687227 B	19-02-1998
		AU 3093695 A	04-03-1996
		BR 9506276 A	12-08-1997
		CA 2169649 A	15-02-1996
		CN 1130963 A	11-09-1996
		EP 0721704 A	17-07-1996
		FI 961414 A	20-05-1996
		JP 9506231 T	17-06-1997
		ZA 9505940 A	01-02-1996
WO 9703403 A	30-01-1997	FI 953414 A	13-01-1997
		AU 6361496 A	10-02-1997
		CA 2225232 A	30-01-1997
		CN 1191048 A	19-08-1998
		EP 0838107 A	29-04-1998
		NO 980108 A	09-01-1998
US 5568483 A	22-10-1996	US 5504773 A	02-04-1996
		US 5103459 A	07-04-1992
		AU 694612 B	23-07-1998
		AU 4760396 A	07-08-1996
		BR 9606833 A	30-12-1997
		CA 2210657 A	25-07-1996
		EP 0804836 A	05-11-1997
		FI 972990 A	17-09-1997
		JP 10512415 T	24-11-1998
		WO 9622639 A	25-07-1996
		AT 156954 T	15-08-1997
		AU 3476793 A	03-08-1993
		AU 683597 B	13-11-1997
		AU 4791196 A	16-05-1996
		CA 2128327 A	22-07-1993
		CN 1081040 A	19-01-1994
		DE 69313098 D	18-09-1997
		DE 69313098 T	12-03-1998
		DK 621998 T	16-03-1998
		EP 0621998 A	02-11-1994
		EP 0730356 A	04-09-1996
		ES 2108260 T	16-12-1997
		FI 943410 A	16-09-1994
		GR 3025048 T	30-01-1998
		HK 1000689 A	17-04-1998
		IL 104412 A	14-11-1996
		IL 118832 A	10-03-1998
		JP 7506469 T	13-07-1995
		NO 942670 A	16-09-1994
		PL 172909 B	31-12-1997
		WO 9314588 A	22-07-1993
		US 5511073 A	23-04-1996
		ZA 9300290 A	22-11-1993
		AU 652956 B	15-09-1994
		AU 8401691 A	23-01-1992
		BG 61514 B	31-10-1997
		BG 97222 A	27-05-1994
		CA 2085890 A	26-12-1991
		CN 1061312 A	20-05-1992
		CZ 283123 B	14-01-1998

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inta. Jonal Application No

PCT/US 98/13103

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5568483 A		EP 0536334 A	14-04-1993
		FI 925812 A	21-12-1992
		HU 64657 A	28-01-1994
		IL 98598 A	27-02-1994
		JP 6501349 T	10-02-1994
		KR 134390 B	27-04-1998
		MX 173818 B	29-03-1994
		PT 98079 A	31-08-1993